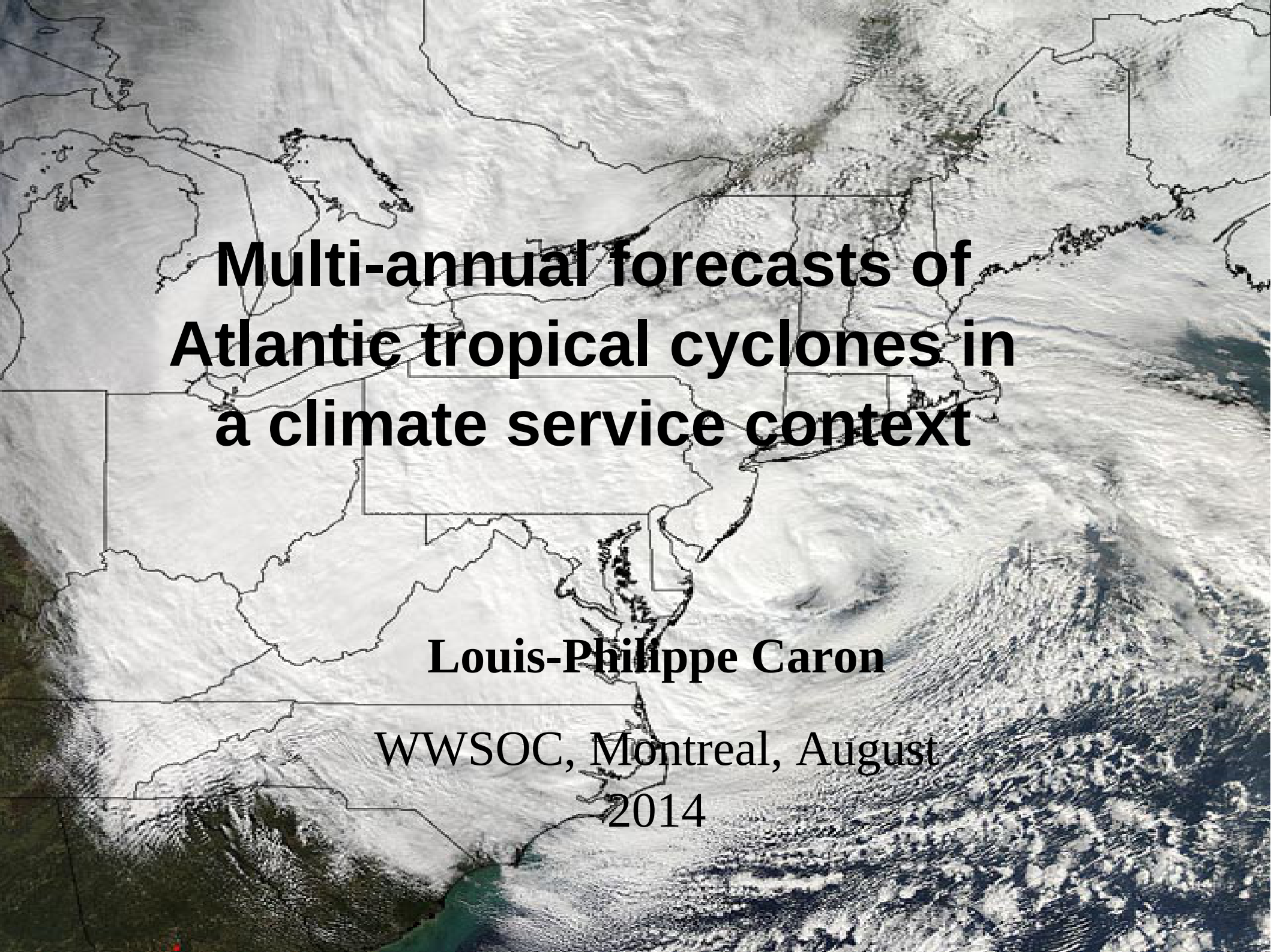


Multi-annual forecasts of Atlantic tropical cyclones in a climate service context

Louis-Philippe Caron

WWSOC, Montreal, August 2014

Objectives

- Evaluating the capability of initialized GCMs at predicting Atlantic Tropical Cyclone activity over a 5-year horizon
- Evaluating predictability of climate shifts from active to inactive regime (and vice-versa)

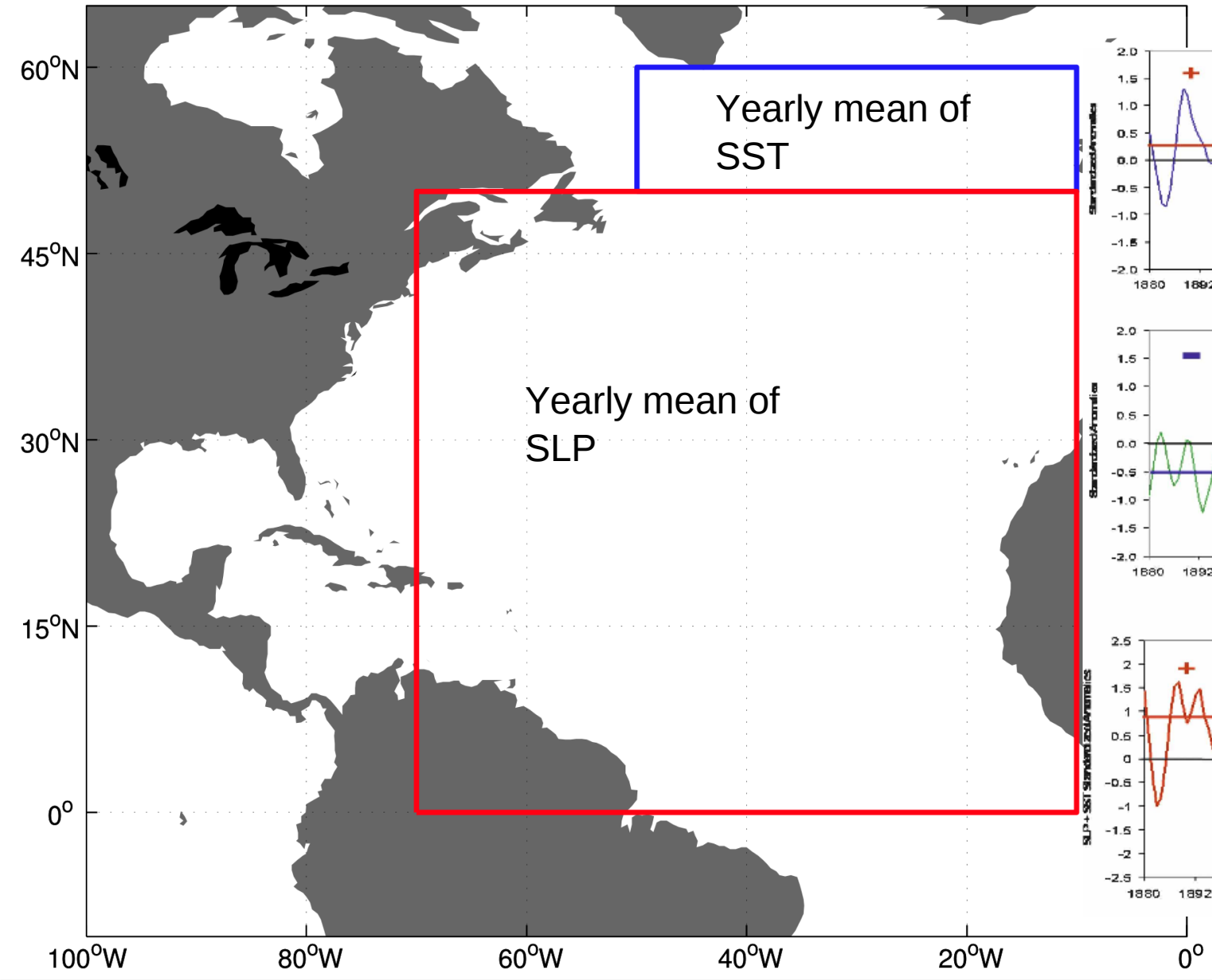
Two techniques are typically used to evaluate TC activity in climate simulations:

1. Direct analysis of tropical cyclones statistics
   - Low-res GCMs are bad at simulating TC activity in the Atlantic
   - Huge amount of data required

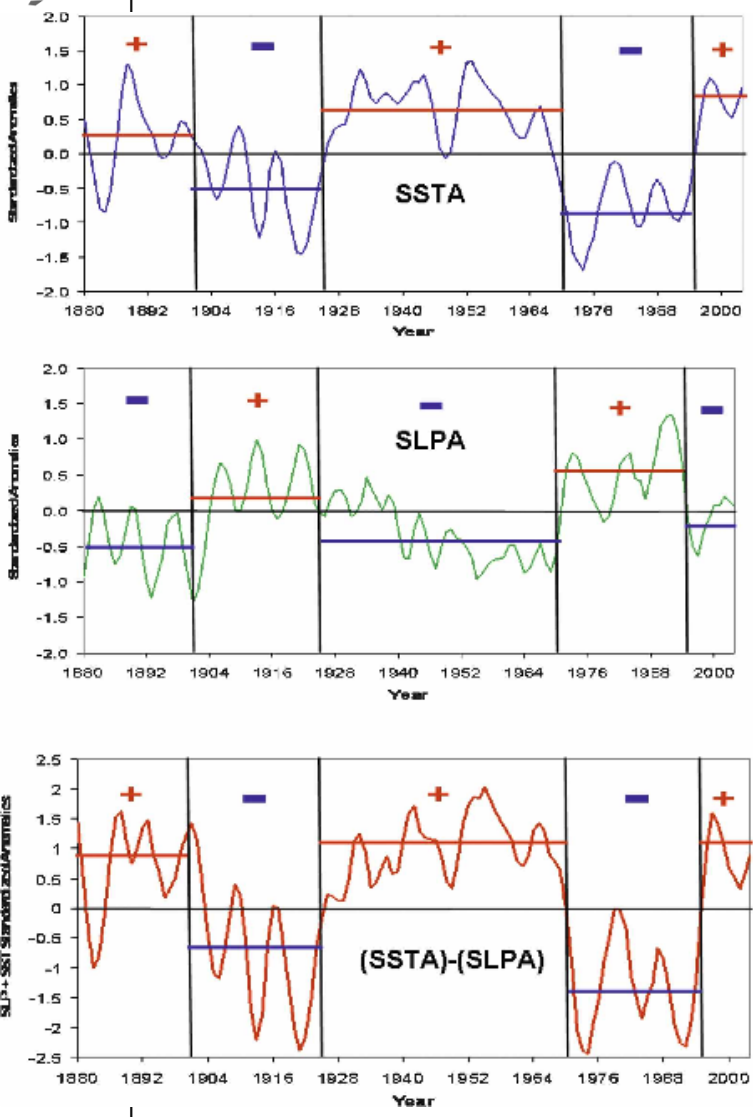
1. Indirectly through changes in large-scale fields that impact TC activity

Climate factors influencing Atlantic hurricane activity

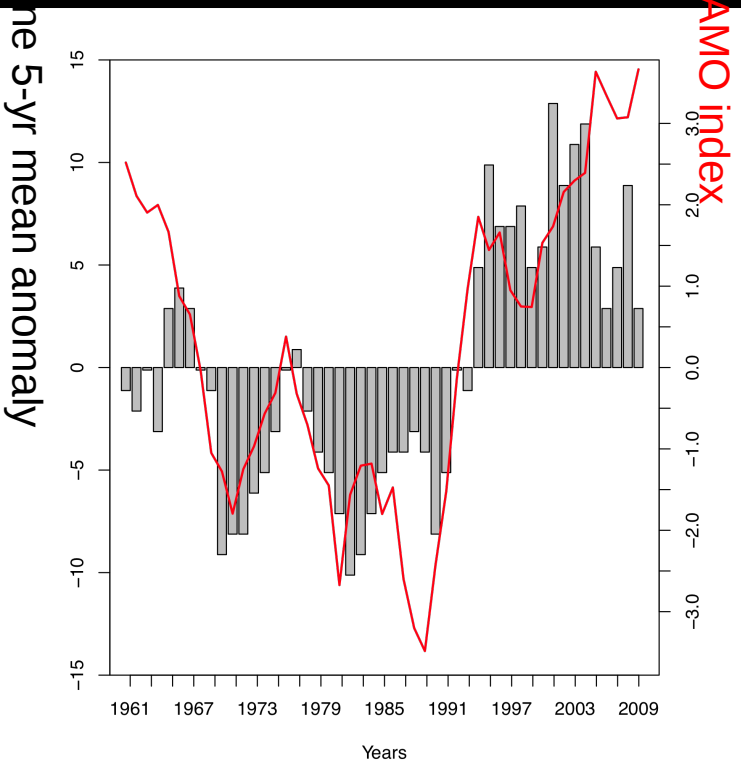
Climate factor	Description	Timescale
Atlantic Multidecadal Oscillation (AMO or AMV)	Oscillation in North Atlantic Ocean Temp.	Decadal
El Niño Southern Oscillation	Oscillation in Tropical Pacific Ocean Temp.	Annual (~3-5 yr cycle)
West African Monsoon	Rainfall over Sahel region	Annual
North Atlantic Oscillation (NAO)	Seesaw pattern in sea level pressures b/w Iceland and the Azores	Annual
Solar activity		11-year cycle
Ozone concentration in upper atmosphere		Annual
Dust/aerosols over the Atlantic	Dust originating from Sahara desert	Annual
Maidden-Julian Oscillation	Eastward propagating disturbances in the tropics	Intra-seasonal



AMO index definition:

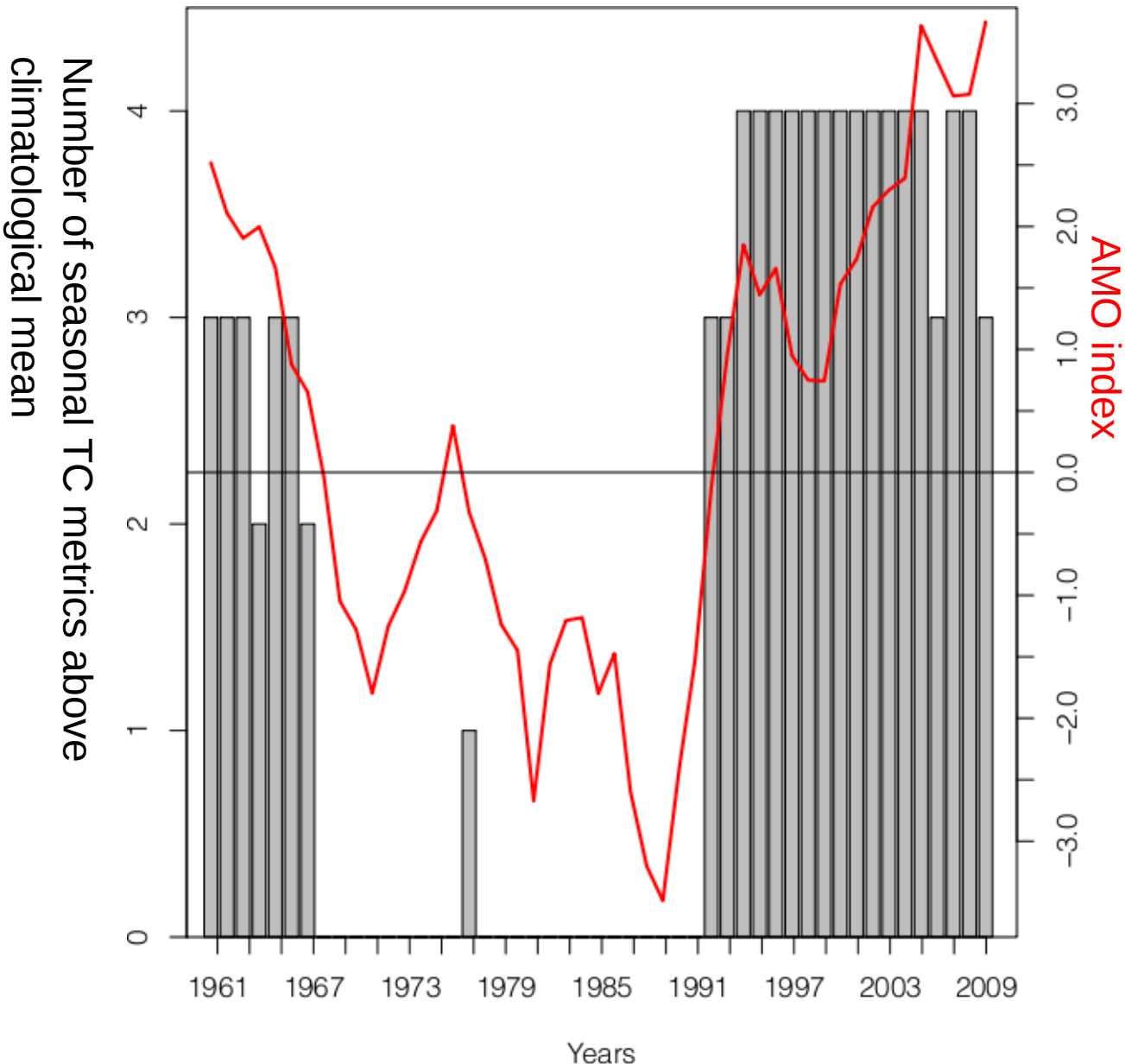


from Klotzbach and Gray (2008)



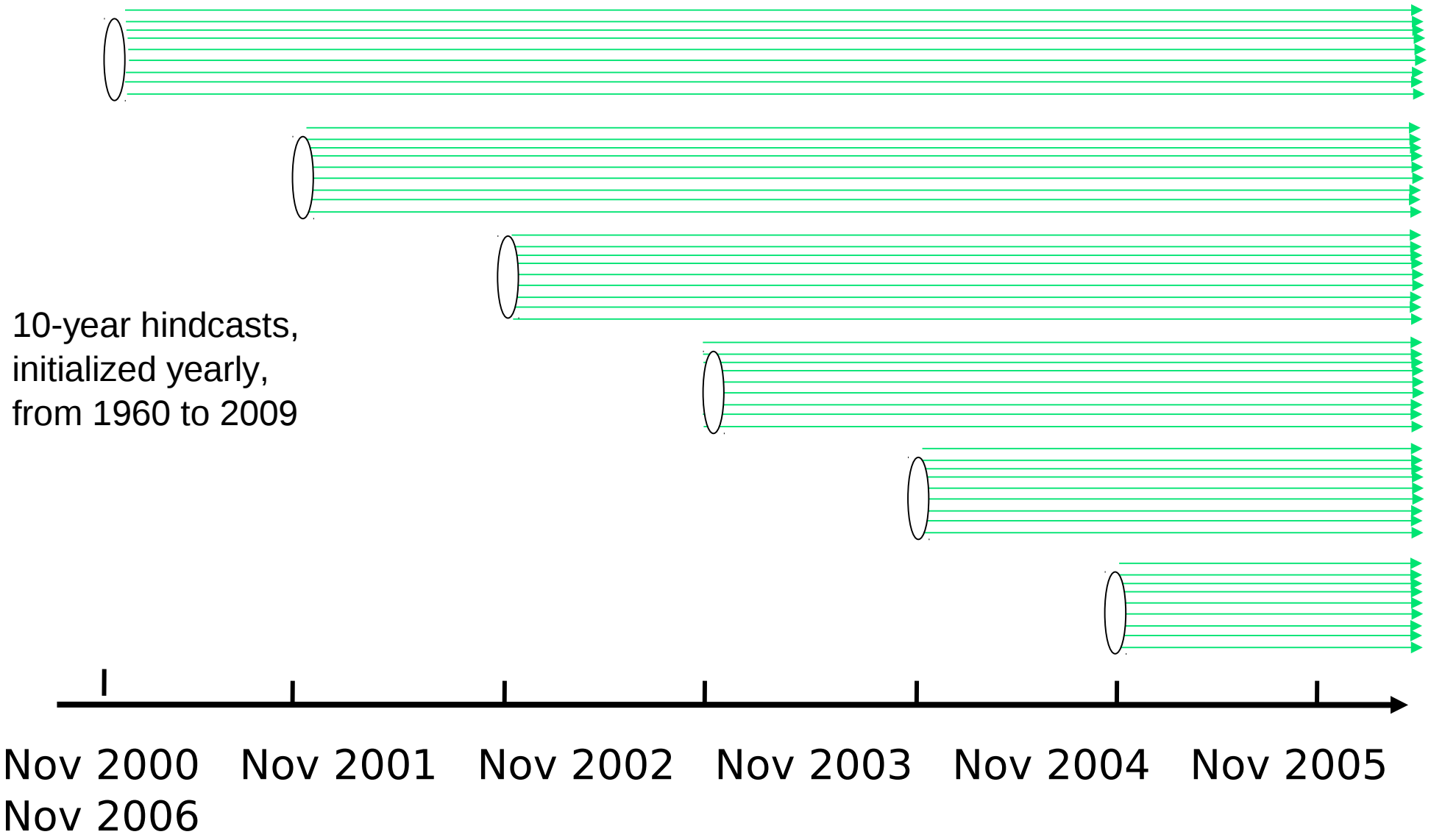
TC metrics are:

- **Number of hurricanes**
- **Number of major hurricanes**
- **Number of hurricane days**
- **Accumulated Cyclone Energy (ACE)**



Ensemble initialized near-term predictions

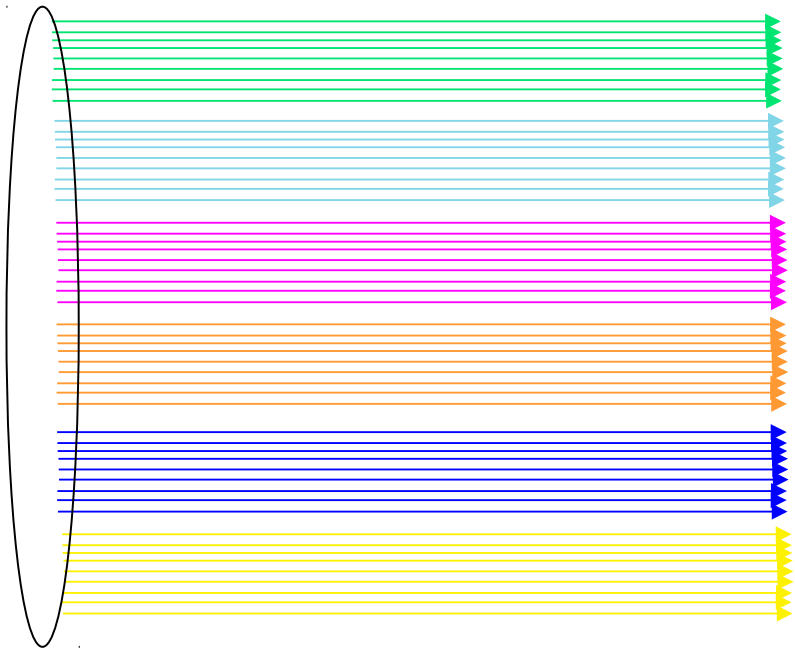
CMIP5: ensemble forecast systems using an initialized ESM



Ensemble climate forecast systems

Assume a multi-model ensemble system with coupled initialized GCMs

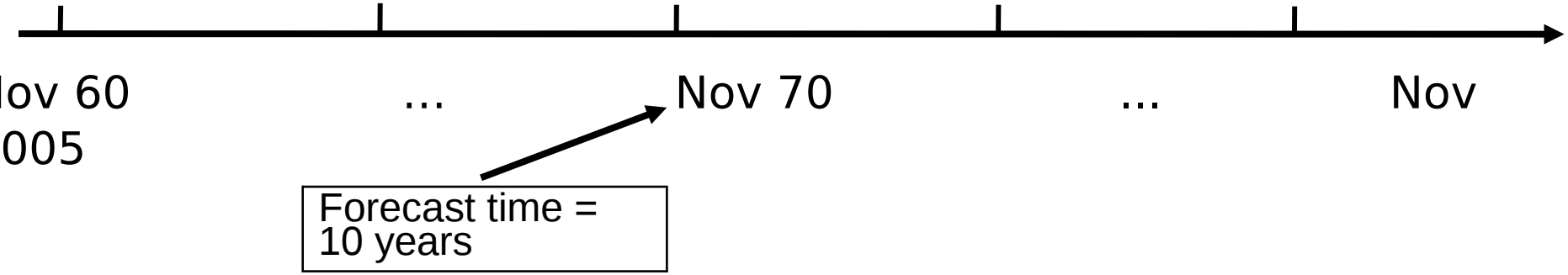
Model 1 Model 2 Model 3 Model 4 Model 5 Model 6



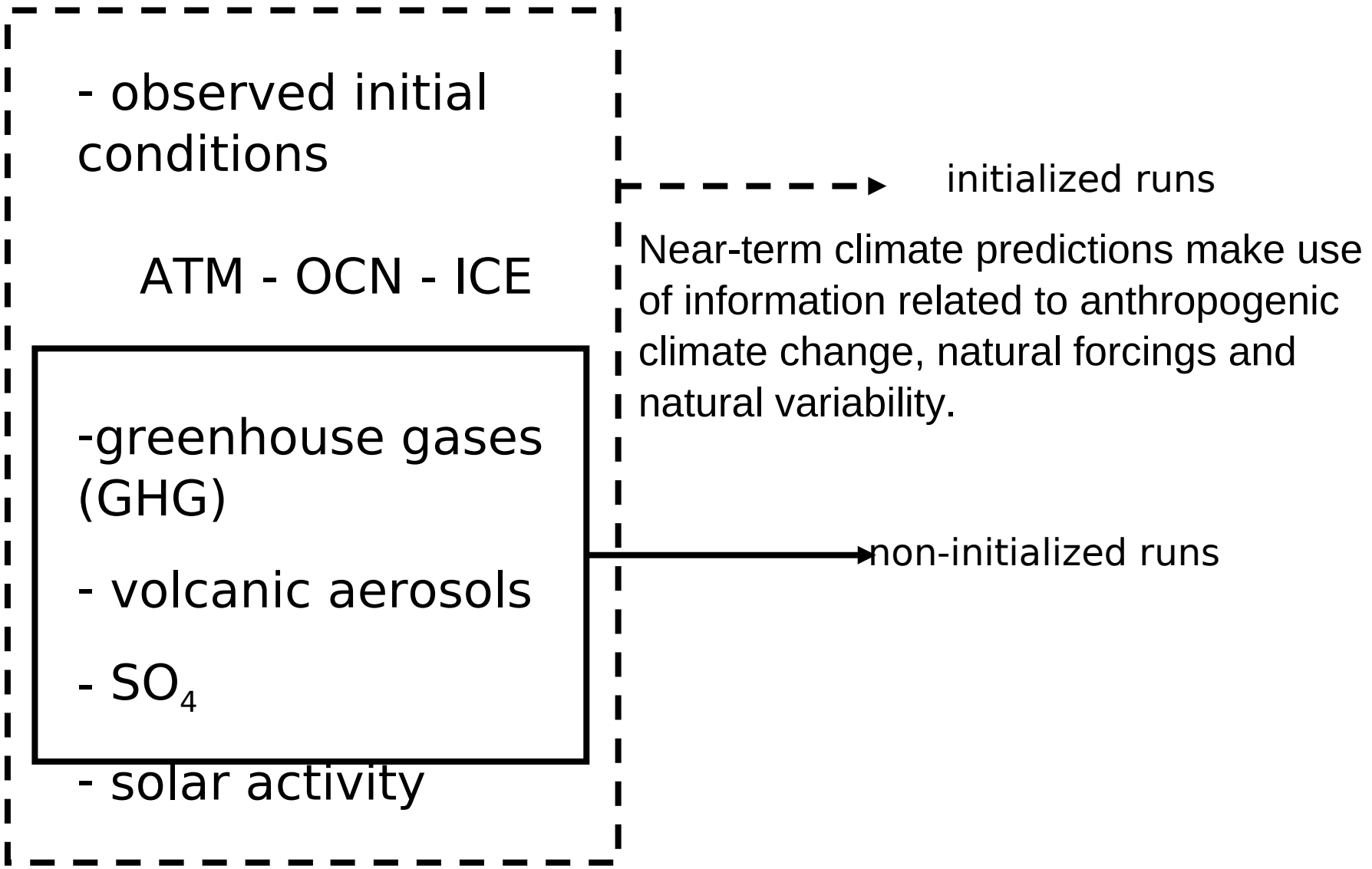
K models x M ensemble members

M*K-member ensemble

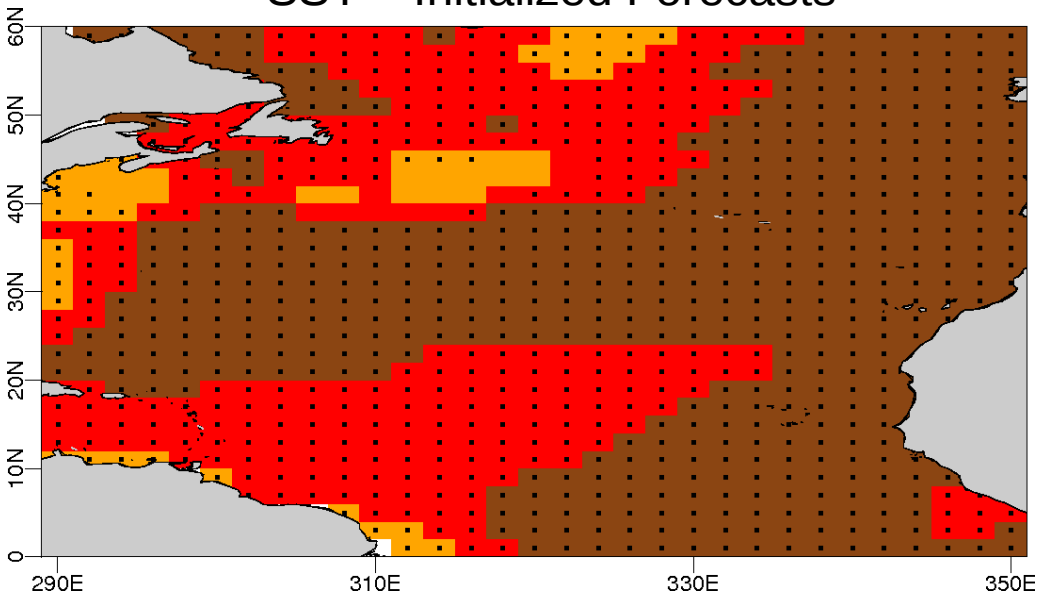
- GFDL CM2.1
- MIROC5
- HadCM3
- MPI-ESM
- HadGM3



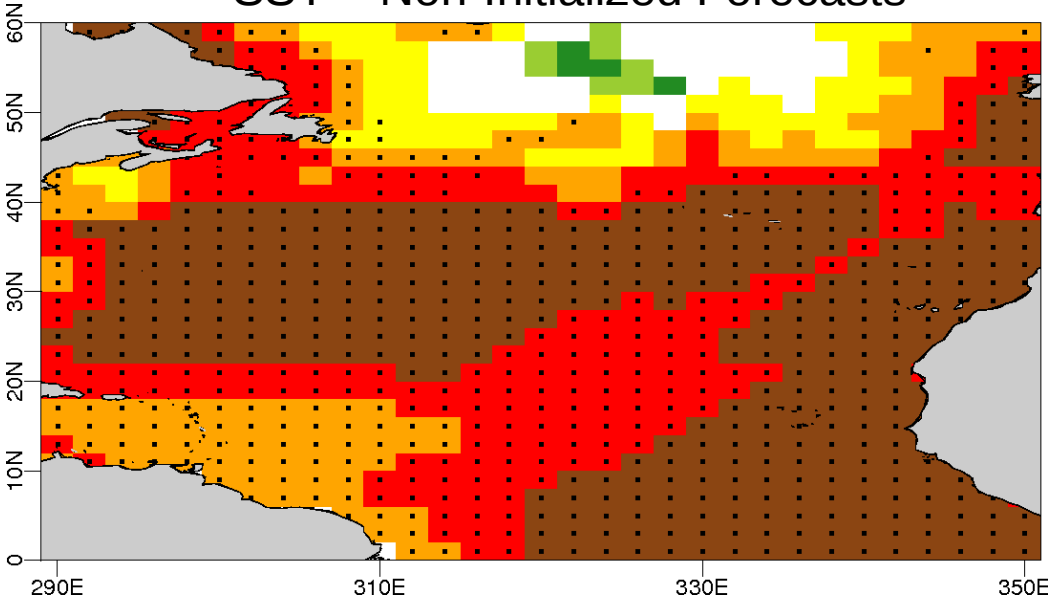
DECADAL RETROSPECTIVE FORECASTS (re-forecasts or hindcasts)



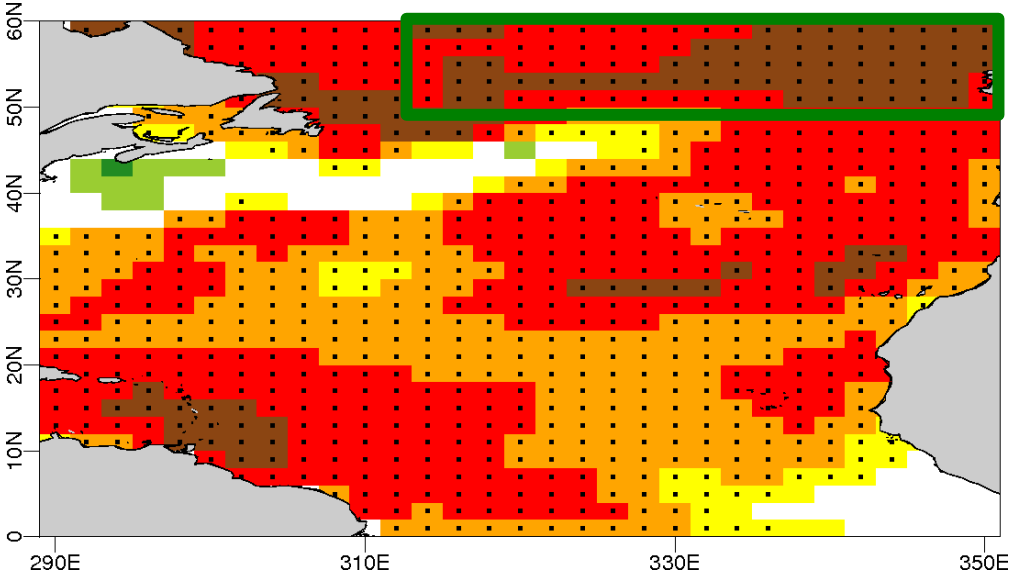
SST – Initialized Forecasts



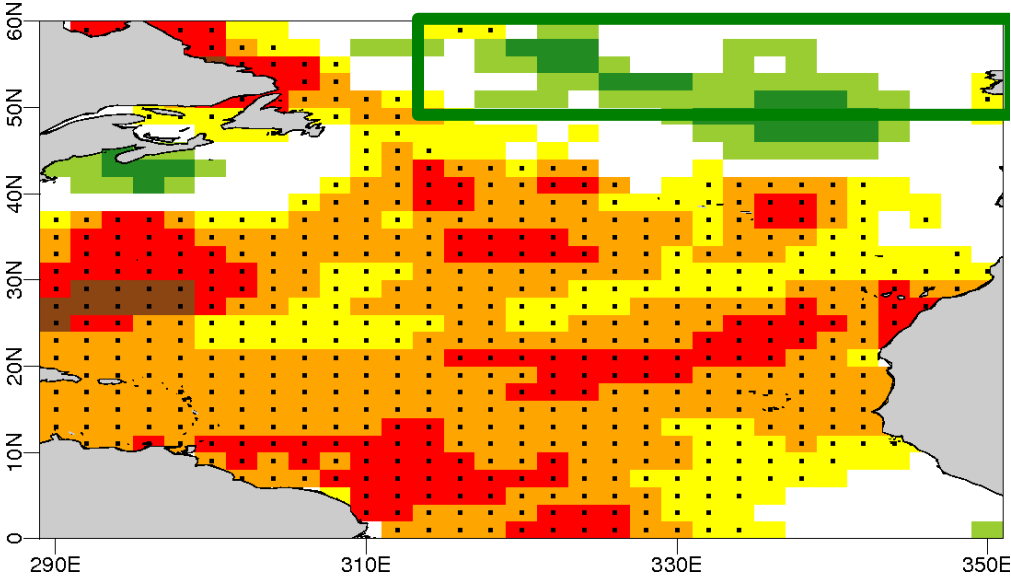
SST – Non-Initialized Forecasts



Detrended SST – Initialized Forecasts

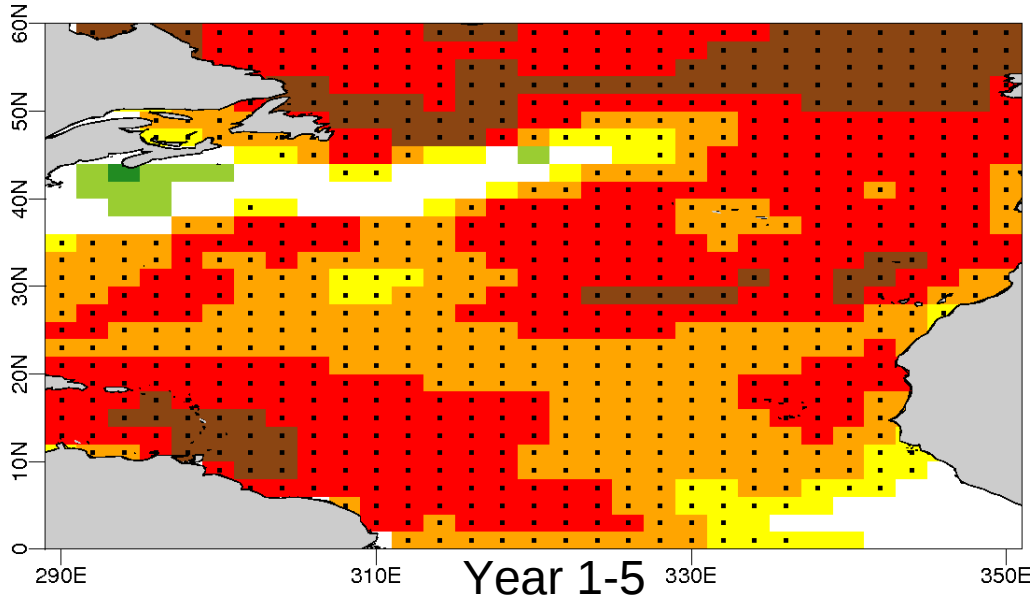


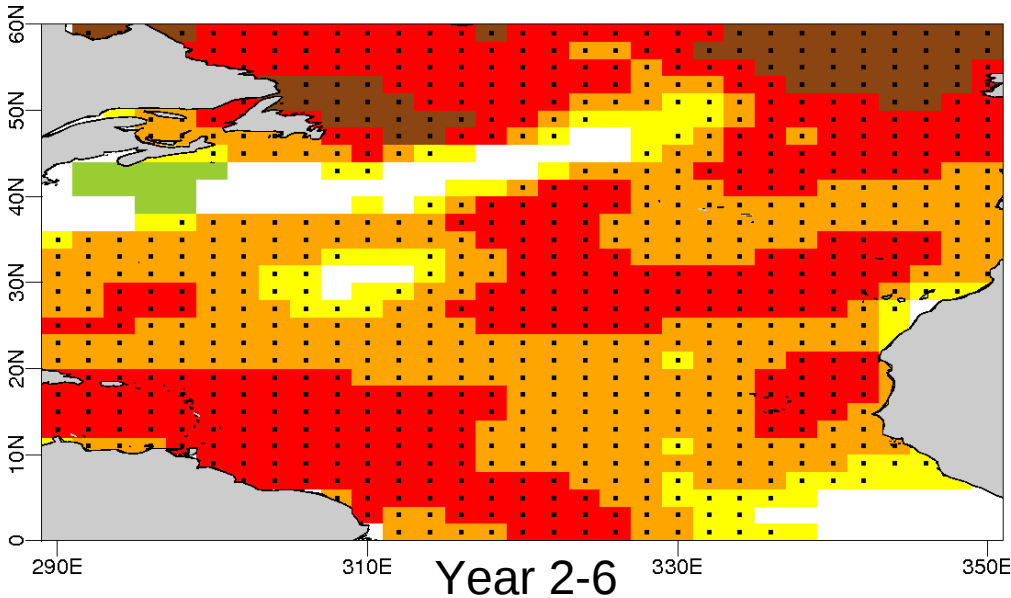
Detrended SST – Non-Initialized Forecasts

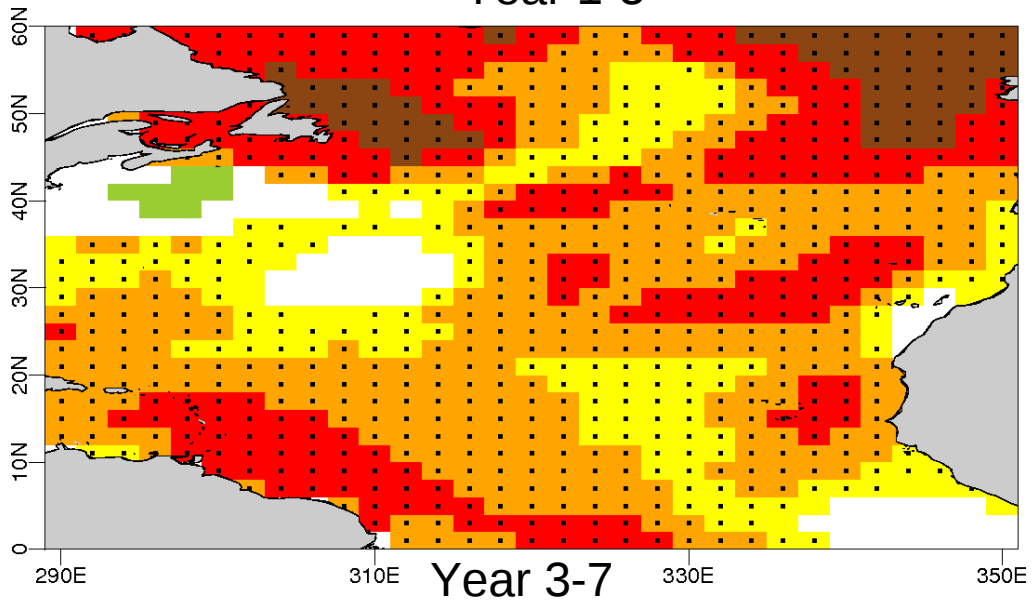


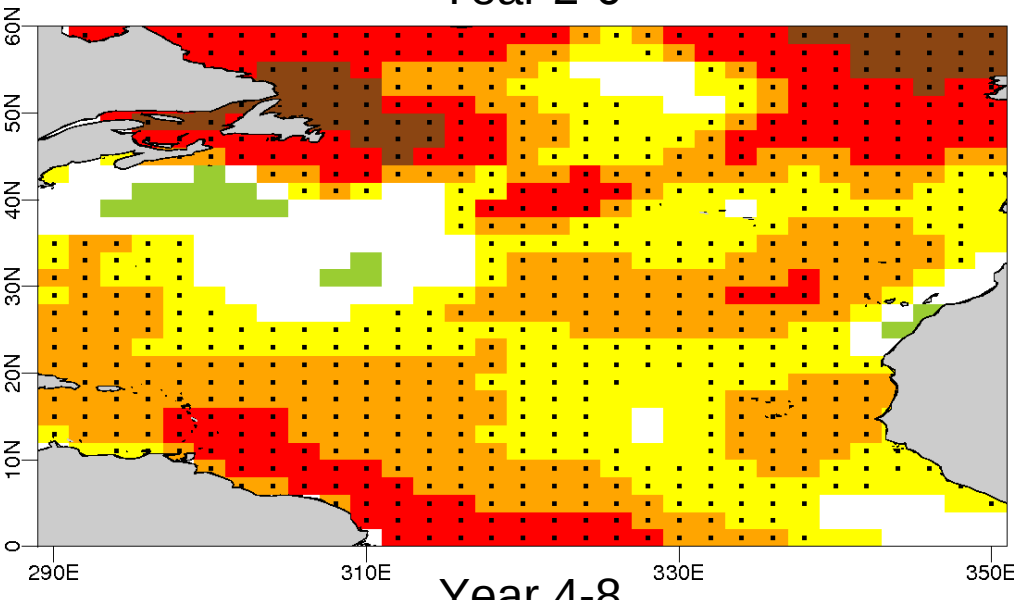
ACC Year 1-5

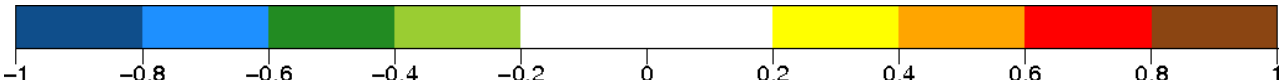
ACC, 5-year mean detrended SST – Initialized Forecasts



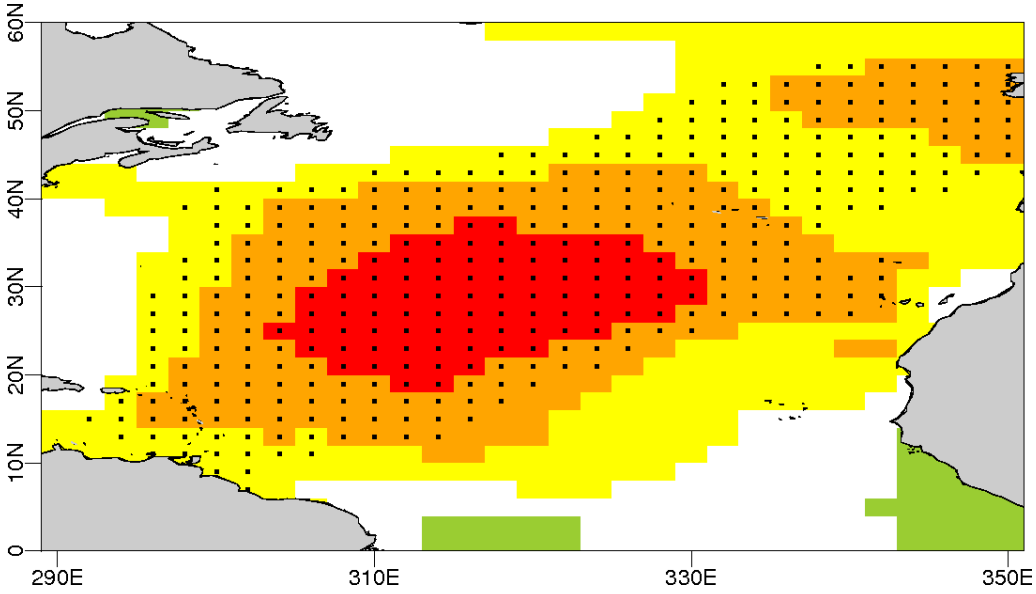




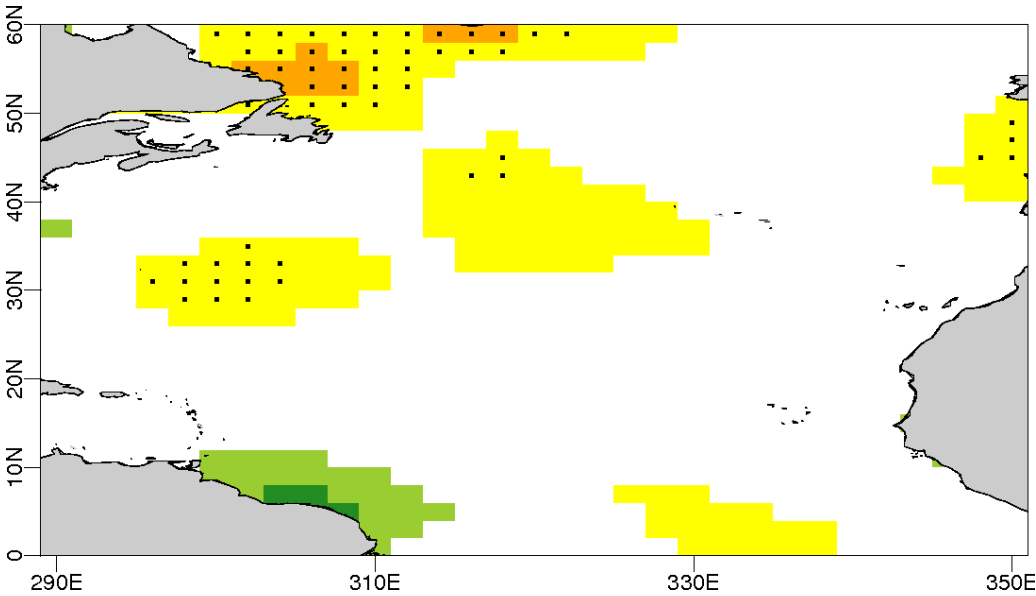


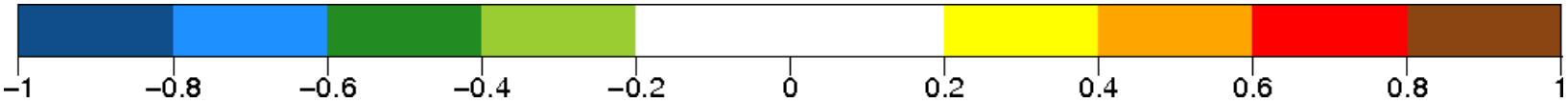


MSLP – Initialized Forecasts



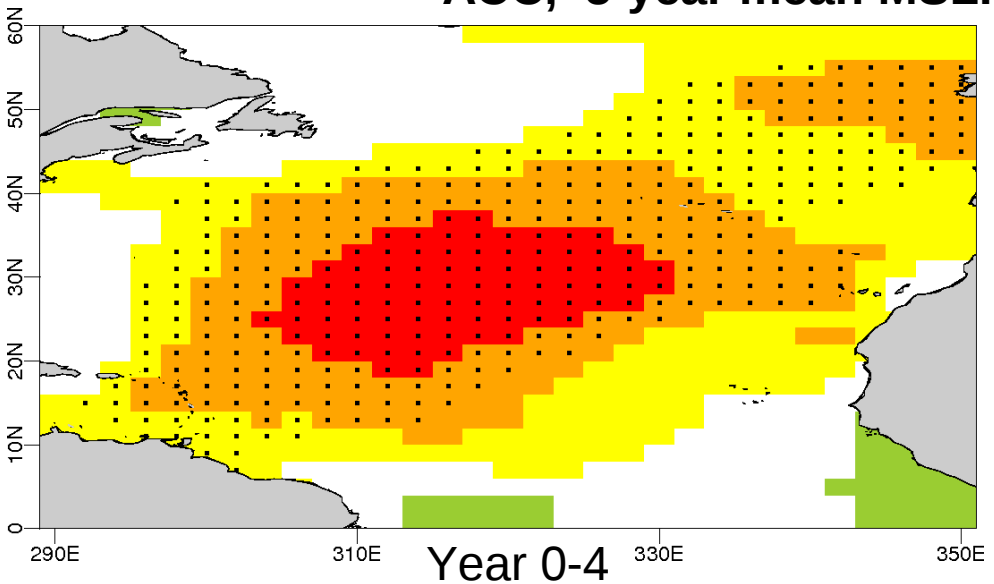
MSLP – Non-Initialized Forecasts



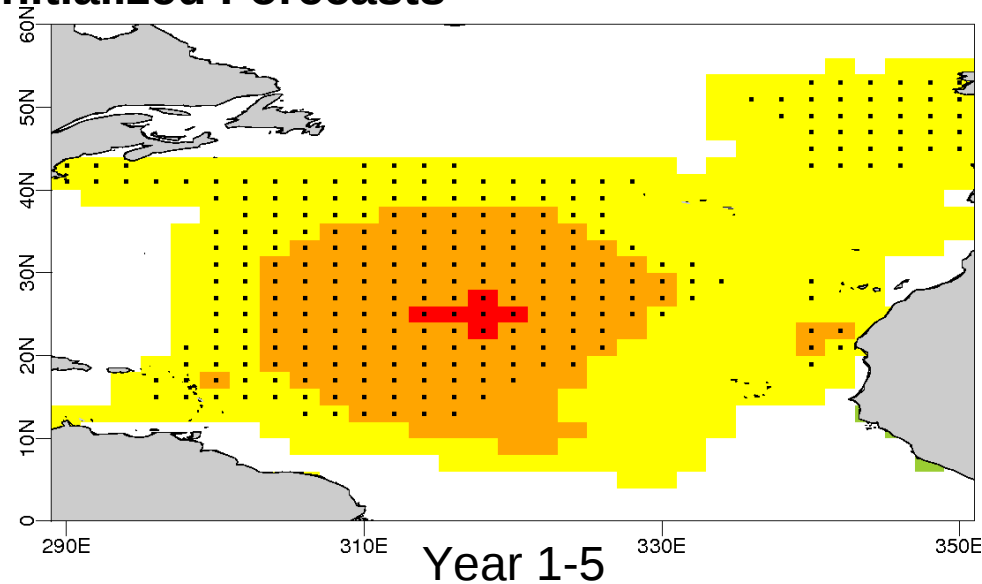


ACC Year 1-5

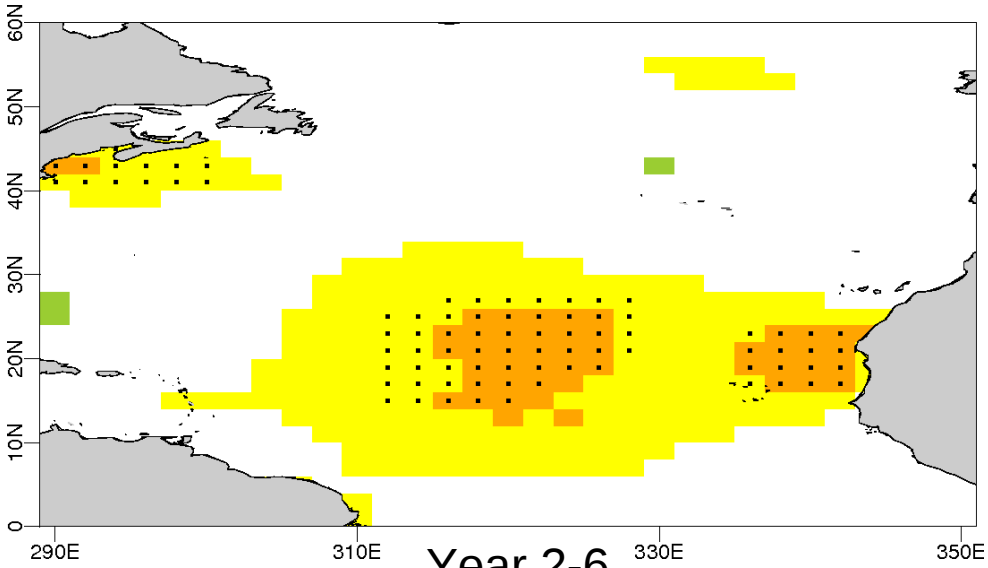
ACC, 5-year mean MSLP – Initialized Forecasts



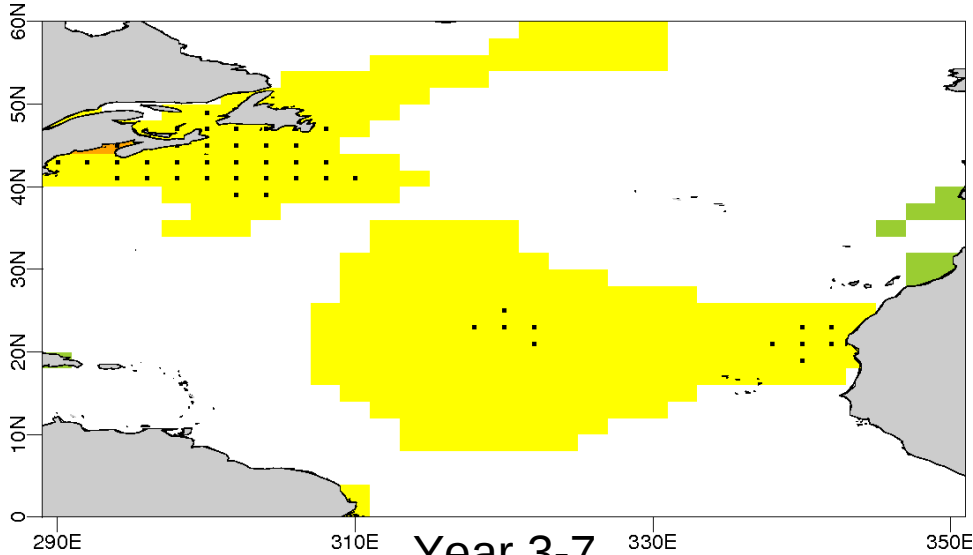
Year 0-4



Year 1-5

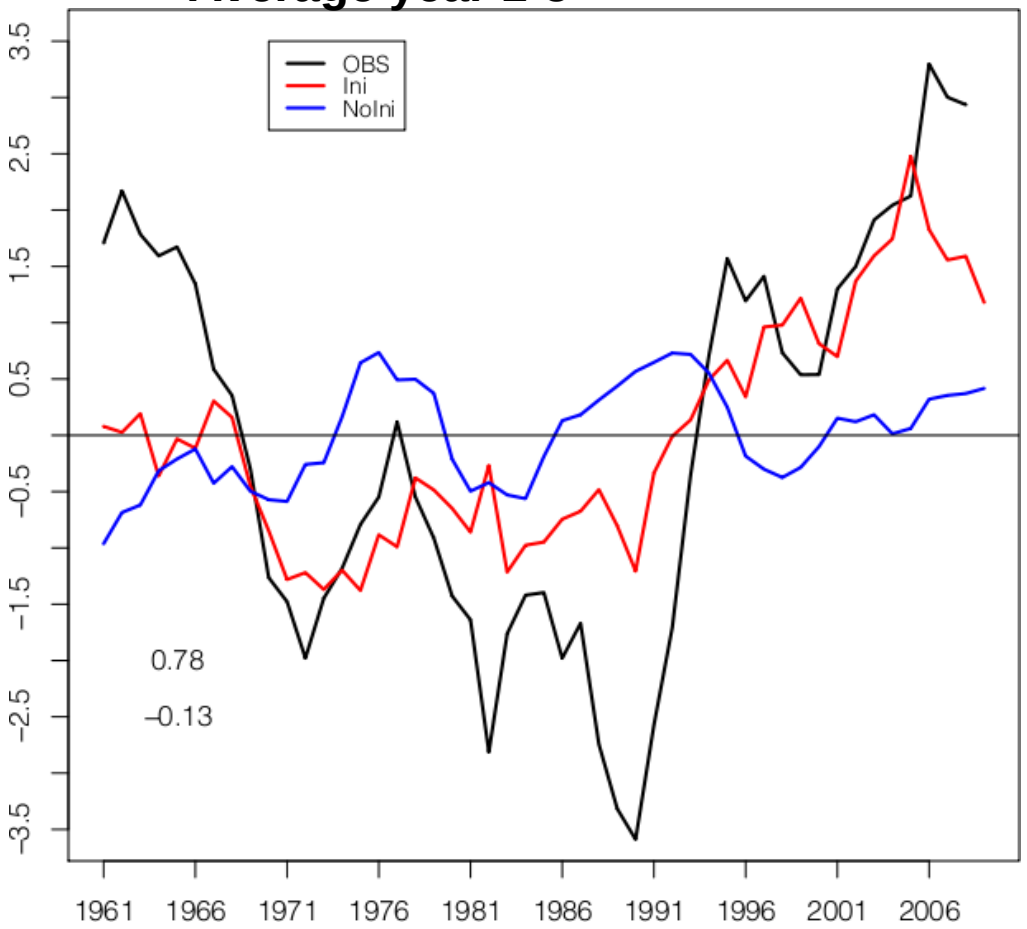


Year 2-6

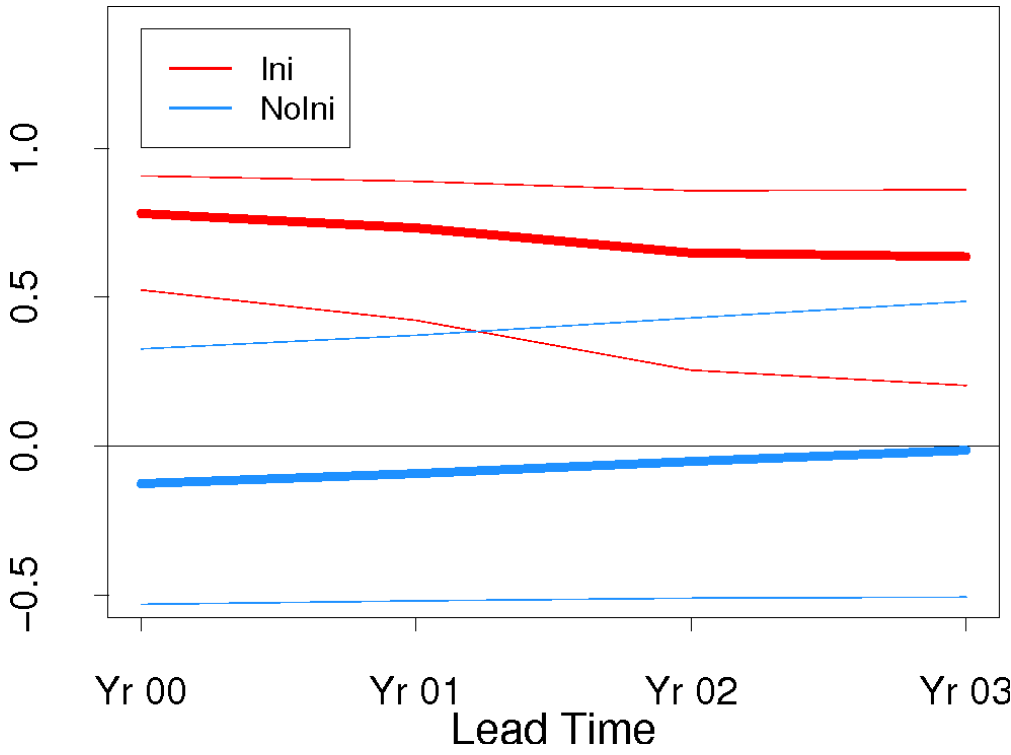


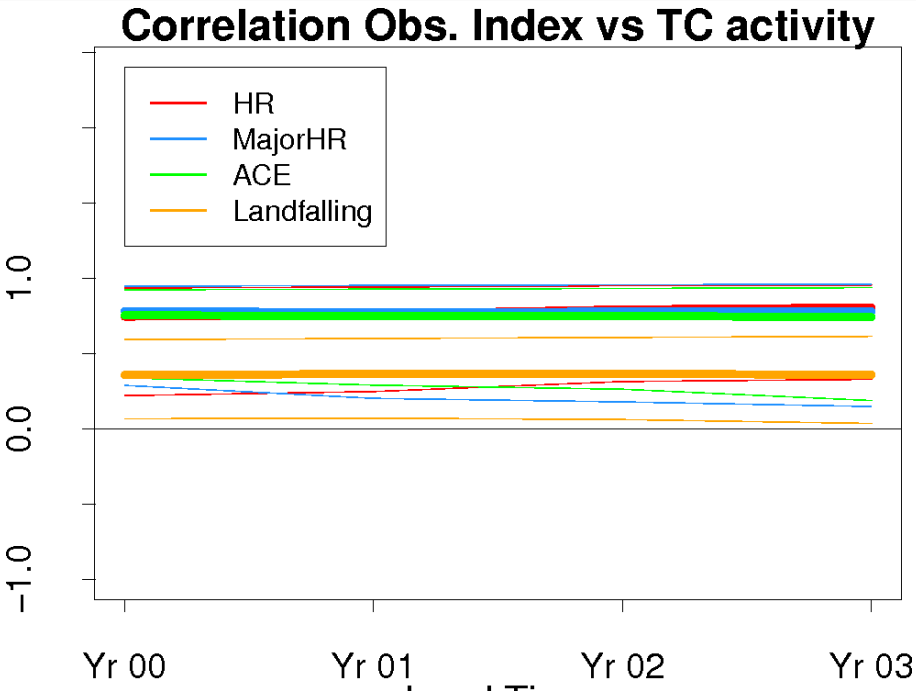
Year 3-7

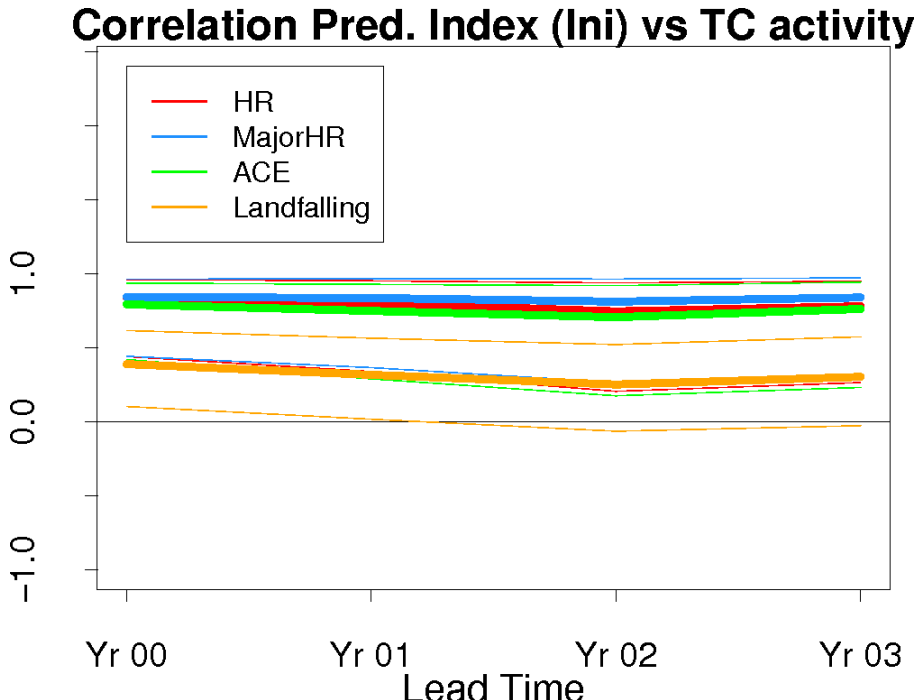
AMO index
Average year 1-5

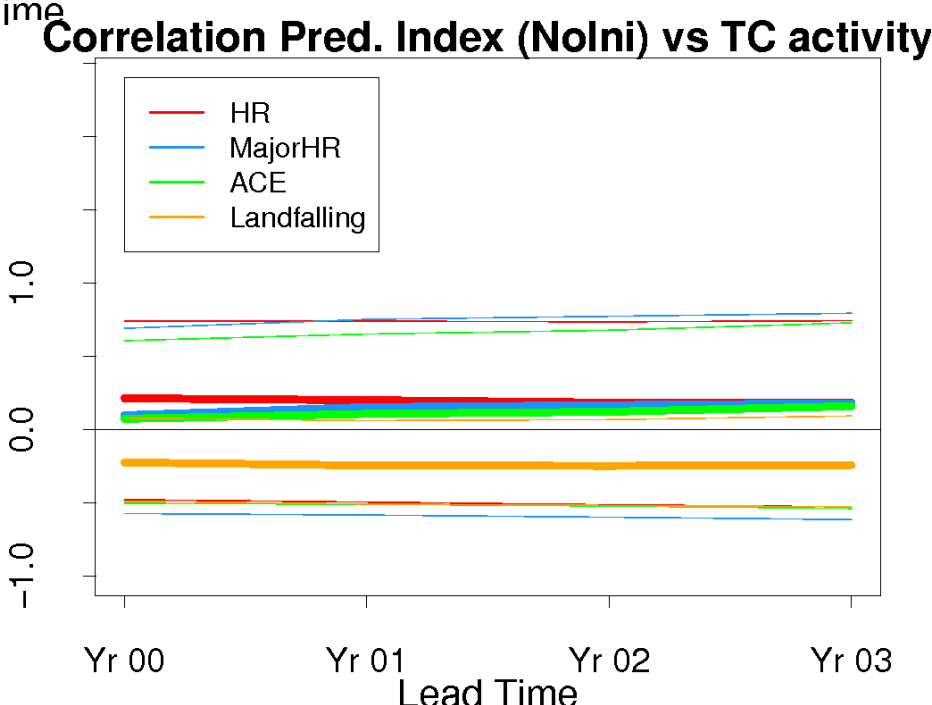


ACC – 5 year mean

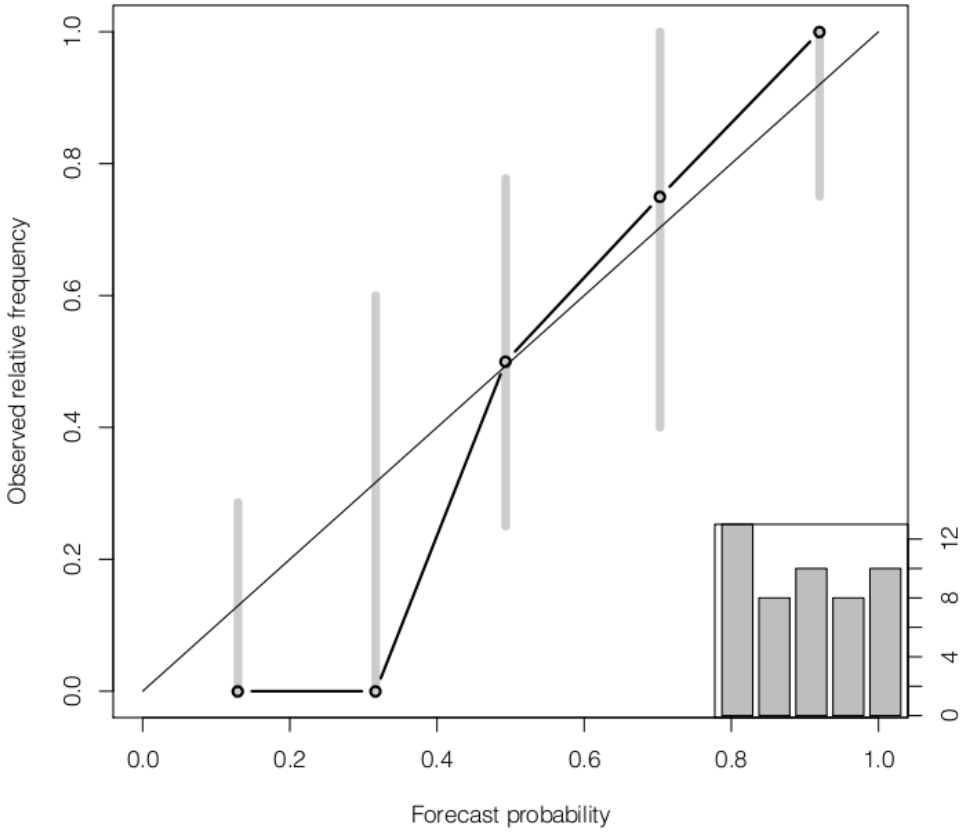



Correlation Obs. Index vs TC activity
HR
MajorHR
ACE
Landfalling
1.0
0.0
−1.0
Yr 00
Yr 01
Yr 02
Yr 03
Lead Time

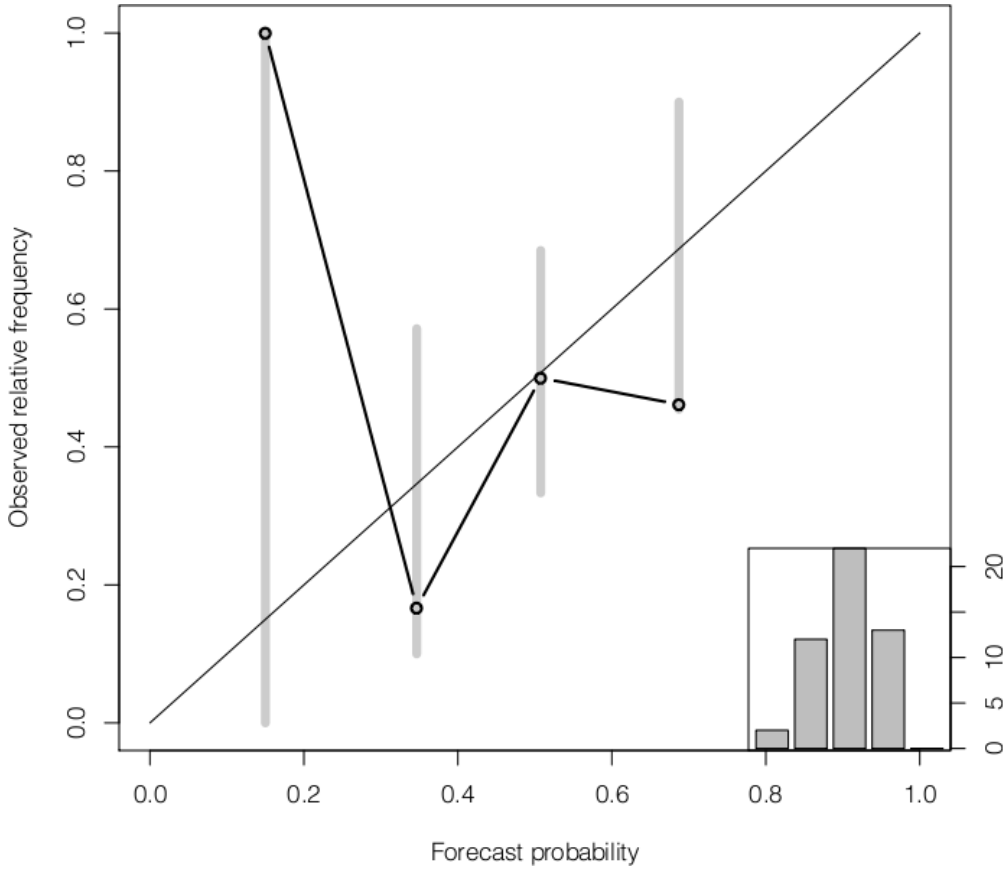

Correlation Pred. Index (Ini) vs TC activity
HR
MajorHR
ACE
Landfalling
1.0
0.0
−1.0
Yr 00
Yr 01
Yr 02
Yr 03
Lead Time


Correlation Pred. Index (NoIni) vs TC activity
HR
MajorHR
ACE
Landfalling
1.0
0.0
−1.0
Yr 00
Yr 01
Yr 02
Yr 03
Lead Time

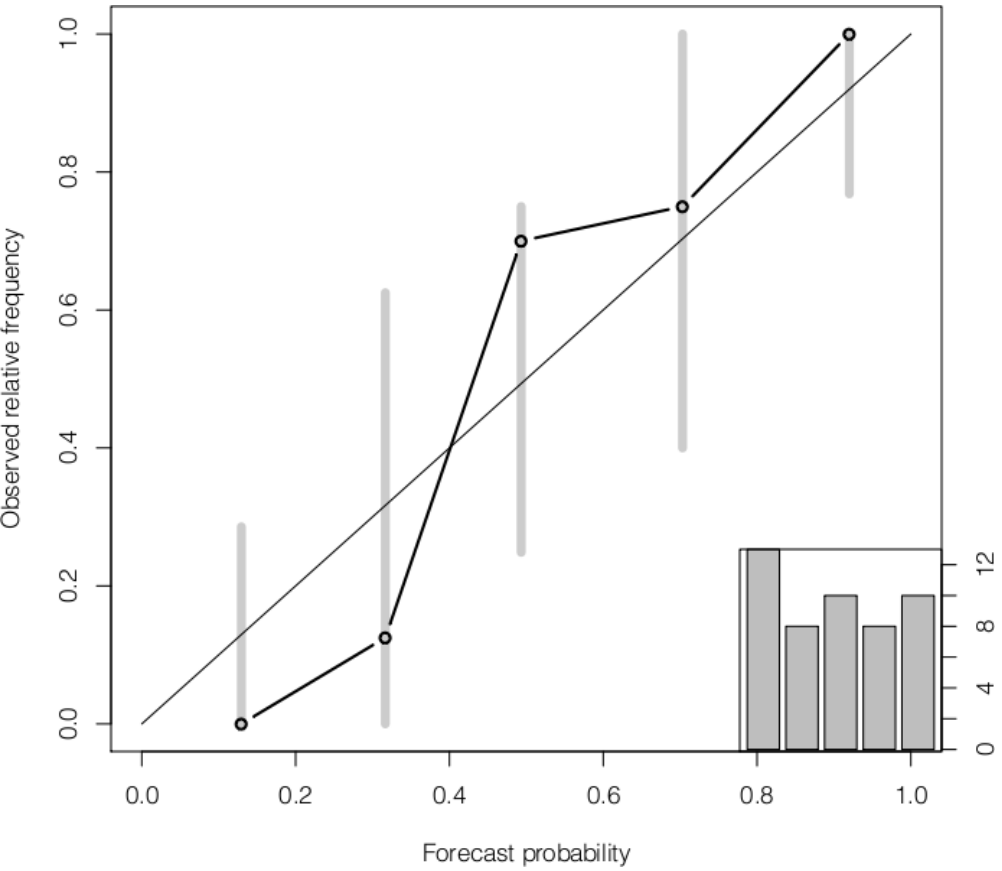
Major Hurricanes
Initialized



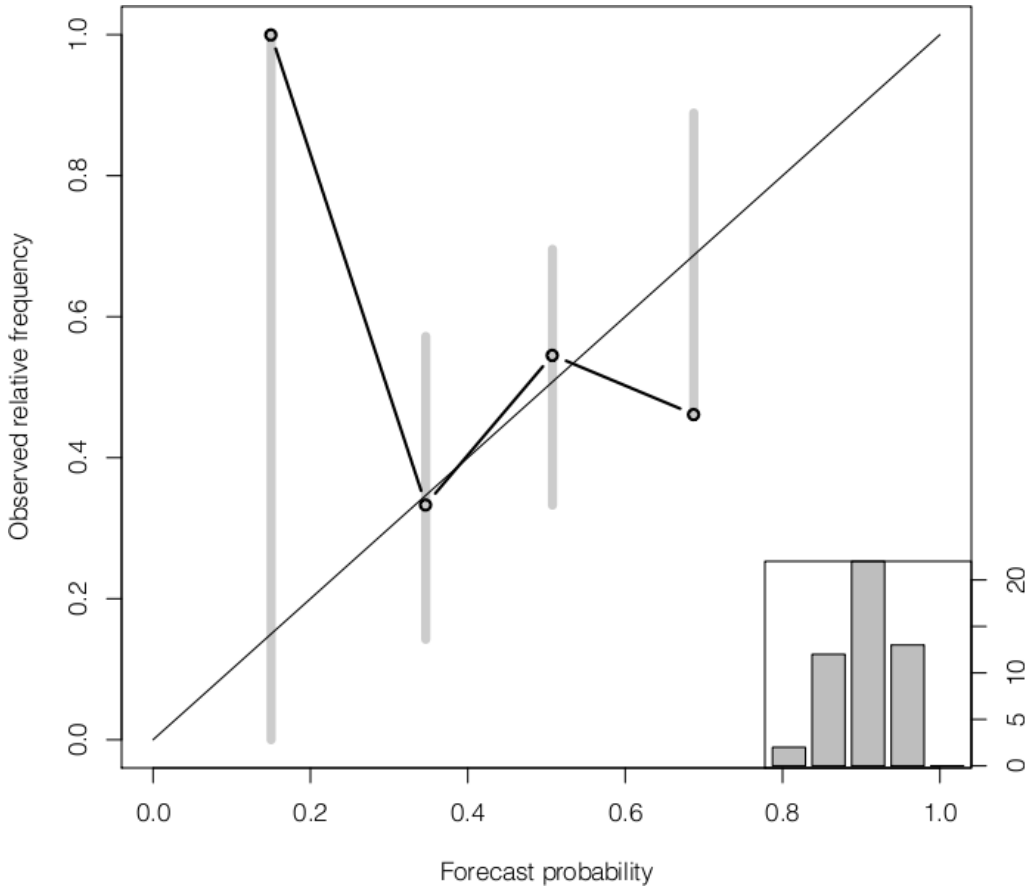
Major Hurricanes
Non-Initialized

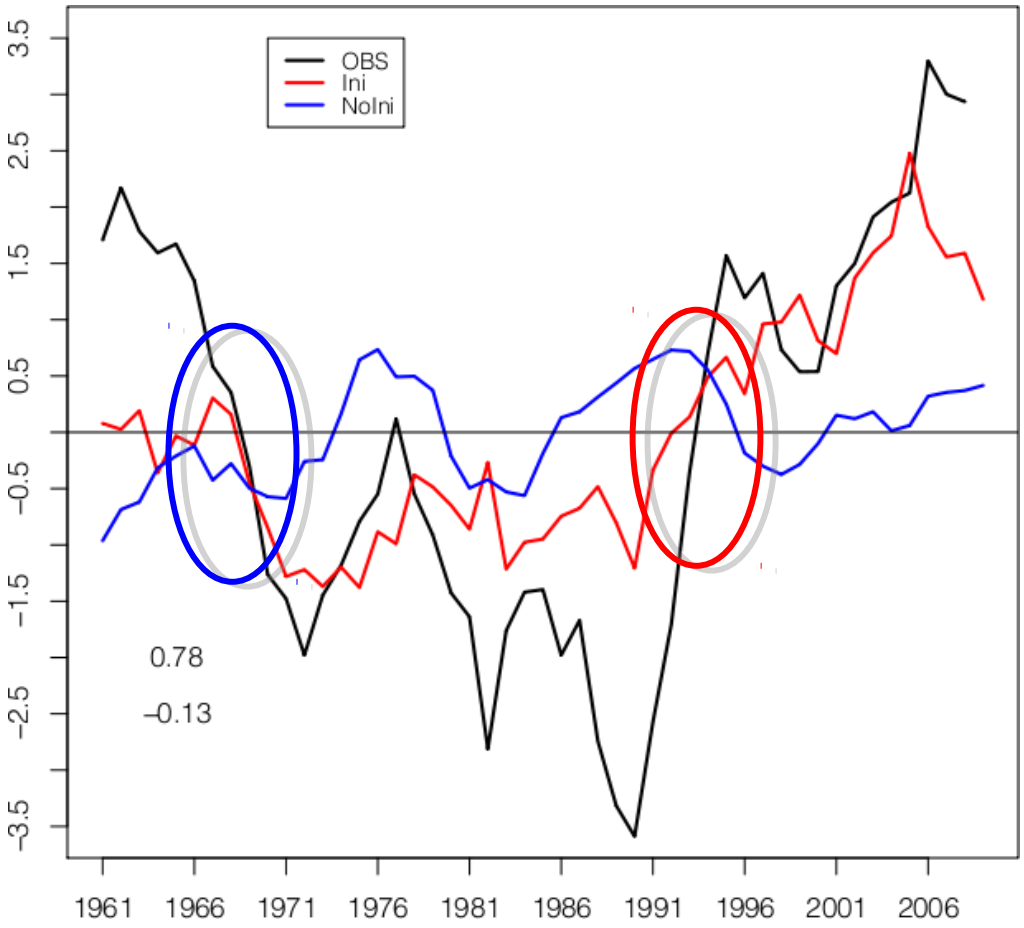


Accumulated Cyclone Energy (ACE) - **Initialized**



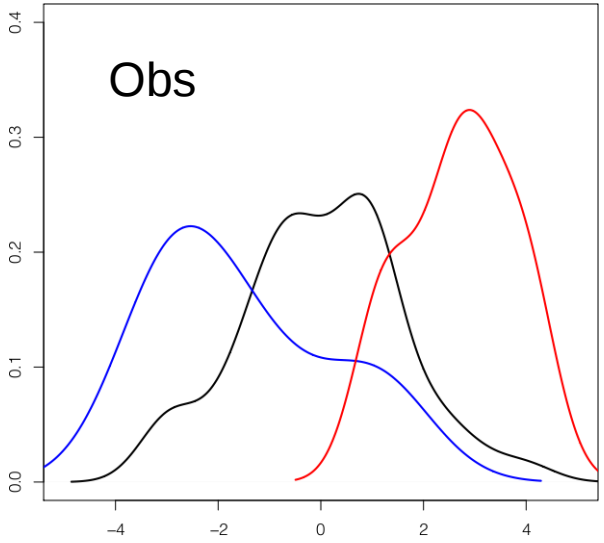
Accumulated Cyclone Energy (ACE) – **Non-Initialized**

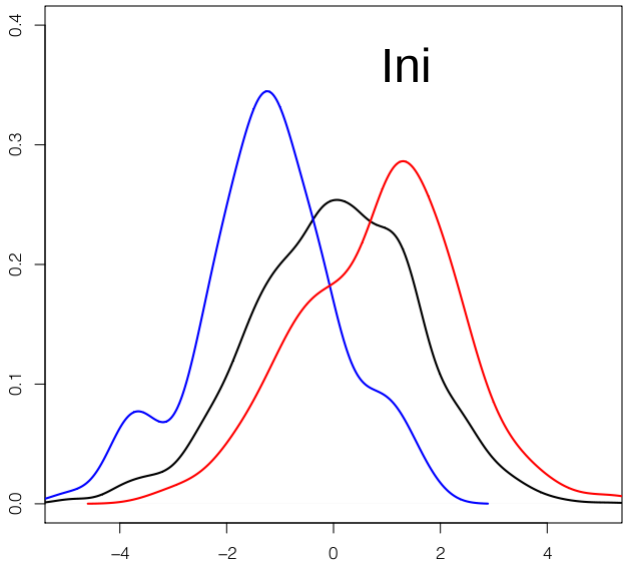




Entire period
1966-1969
1991-1994

Average AMO index
Years 2-6 minus
AMO index Year 1





Summary

- Initialized GCMs do seem capable of predicting AMO index, which is linked to Atlantic TC level, at multi-annual timescale (5yrs)
- Skill doesn’t come only from persistence, i.e. we can predict shift between active and quiet phases

Thank you